

Growth of CuInSe₂:Co single crystal thin film for solar cell development and its solar cell application

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The stoichiometric mixture of evaporating materials for the CuInSe₂ single crystal thin film was prepared from horizontal furnace. Using extrapolation method of X-ray diffraction patterns for the polycrystal CuInSe₂, it was found tetragonal structure whose lattice constant a_0 and c_0 were 5.783 Å and 11.621 Å, respectively. To obtain the CuInSe₂ single crystal thin film, CuInSe₂ mixed crystal was deposited on throughly etched GaAs(100) by the HWE(Hot Wall Epitaxy) system. The source and substrate temperature were 620 °C and 410 °C respectively. The crystalline structure of CuInSe₂ single crystal thin film was investigated by the double crystal X-ray diffraction(DCXD). Hall effect on this sample was measured by the method of Van der Pauw and studied on carrier density and mobility depending on temperature. From Hall data, the mobility was likely to be decreased by impurity scattering in the temperature range 30 K to 100 K and by lattice scattering in the temperature range 100 K to 293 K. The temperature dependence of the energy band gap of the CuInSe₂ obtained from the absorption spectra was well described by the Varshni's relation, $E_g(T) = 1.1851 \text{ eV} - (8.99 \times 10^{-4} \text{ eV/K})T^2/(T + 153 \text{ K})$. The open-circuit voltage, short current density, fill factor, and conversion efficiency of n-CdS/ p-CuGaSe₂ heterojunction solar cells under 80 mW/cm² illumination were found to be 0.33 V, 29.5 mA/cm², 0.78 and 14.7 %, respectively

Keywords: CuInSe₂ single crystal thin film(CuInSe₂ 단결정 박막), Hall effect(Hall 효과), energy band gap

Photocurrent properties for CdIn₂Te₄ single crystal grown by using Bridgman method

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The single crystals of p-CdIn₂Te₄ were grown by the Bridgman method without the seed crystal. From photocurrent measurements, it was found that three peaks, A, B, and C, correspond to the intrinsic transition from the valence band states of $\Gamma_7(A)$, $\Gamma_6(B)$, and $\Gamma_7(C)$ to the conduction band state of Γ_6 , respectively. The crystal field splitting and the spin orbit splitting were found to be 0.2360 and 0.1119 eV, respectively, from the photocurrent spectroscopy. The temperature dependence of the CdIn₂Te₄ band gap energy was given by the equation of $E_g(T) = E_g(0) \approx (9.43 \times 10^{-3})T^2/(2676 + T)$. $E_g(0)$ was estimated to be 1.4750, 1.7110, and 1.8229 eV at the valence band states of A, B, and C, respectively. The band gap energy of p-CdIn₂Te₄ at room temperature was determined to be 1.2023 eV.

Keywords: p-CdIn₂Te₄, photocurrent measurement, Bridgman method, crystal field splitting, spin orbit splitting